New South African records of Erysiphaceae from Transvaal

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A critical examination of the morphology and germination pattern of the anamorphs of South African Erysiphaceae on various host plants was undertaken. The following powdery mildew fungi represent new records for this country and their anamorphs are described in detail: *Erysiphe biocellata, E. cynoglossi, E. galeopsidis, Microsphaera russellii, Sphaerotheca verbenae* and *Uncinula australiana.*

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'n Kritiese studie van die morfologie en kiemingspatroon van die anamorfe van Suid-Afrikaanse Erysiphaceae op verskillende gasheerplante is onderneem. Die volgende meeldouswamme verteenwoordig nuwe aanwinste tot die lys van bekende skimmels vir hierdie land en hul anamorfe word in besonderhede beskryf: *Erysiphe biocellata, E. cynoglossi, E. galeopsidis, Microsphaera russellii, Sphaerotheca verbenae* en *Uncinula australiana.*

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Introduction

Old records of powdery mildew fungi in South Africa are either based on the cleistothecial stage (teleomorph) or on the conidial stage (anamorph). Since the teleomorphs are seldom found in this country (Doidge 1915), most powdery mildews have simply been identified as *Oidium* sp. (Doidge 1950). However, as many powdery mildew fungi can now be identified on the basis of various anamorph characteristics (Boesewinkel 1977, 1980; Braun 1980) and conidial germ tube morphology (Hirata 1942, 1955; Zaracovitis 1965; Braun 1977), a critical examination of the morphology and germination pattern of the anamorphs of South African Erysiphaceae on various host plants was deemed necessary. During this study a number of powdery mildew fungi were observed which had not previously been reported in this country. This is the first contribution on these fungi in which the anamorphs are described in detail.

Materials and Methods

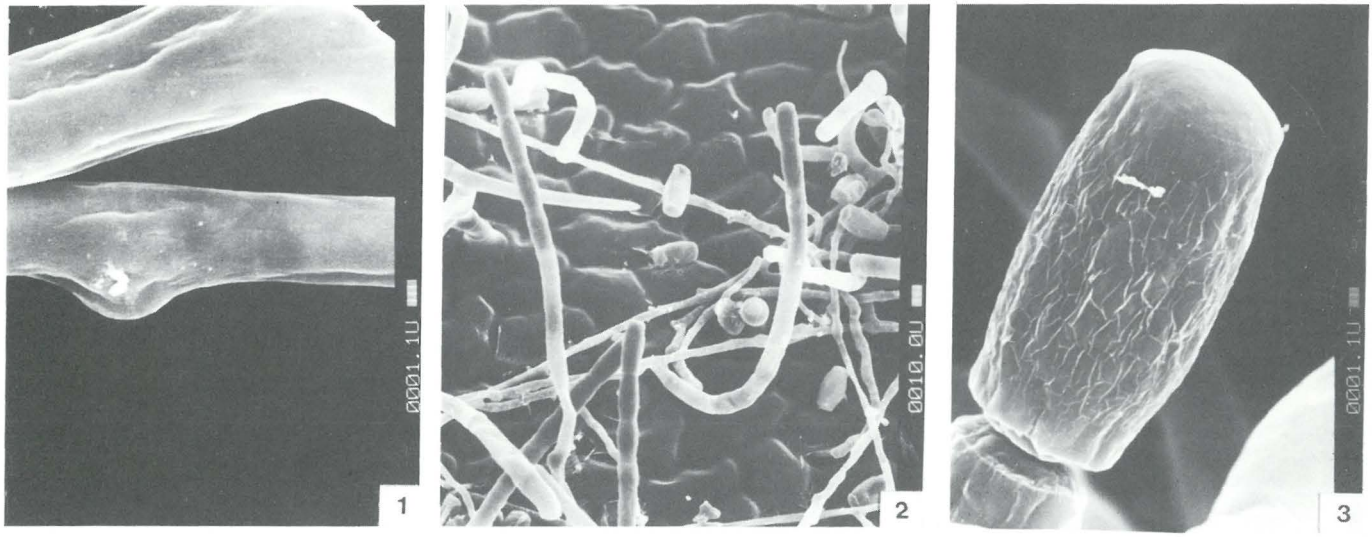
Fresh material of the described fungi was collected in the vicinity of Pretoria. Treatment and observation of these samples followed the procedures outlined in a previous paper (Gorter & Eicker 1983) with the difference that the germination of conidia was carried out in the dark in an incubator at 20 °C. Material of the collections examined has been deposited in the Mycological Herbarium of the Plant Protection Research Institute, Pretoria, (PREM).

Descriptions

Erysiphe biocellata Ehrenb.

Mycelium dense, white, amphigenous and on flower stalks. Hyphae slightly flexuous, branching at right angles near septum. Hyphal cells 45 – 67,5 × 6 – 9 μm. Appressoria poorly developed, normally not more than a thickening of hyphae, seldom clearly nipple-shaped (Figure 1). Conidiophores 2 – 3 celled, straight or slightly bent, numerous, sometimes collapsed near the base (Figure 2), 67 – 135 × 10 – 12,5 μm, producing conidia in long chains. Foot cells 37,5 – 65 × 10 – 12,5 μm with the basal septum sometimes 7,5 – 12,5 μm away from mycelium. Conidia ovoid to elliptic-cylindrical (27,5 –) 32,5 – 37,5 (– 41,2) × (15 –) 17,5 – 20 (– 22,5) μm, without well developed fibrosin bodies (Figure 3). Germ tubes simple, moderately long, straight or slightly flexuous, from end of conidium, apical or subapical. Tubes 35 – 165 × 4 – 5 μm, often ending in an unlobed appressorium of moderate length 7,5 – 15 × 6 – 8,5 μm.

This description agrees closely with Boesewinkel (1979) and



Figures 1 – 3 *Erysiphe biocellata*. 1. Poorly developed unlobed appressorium. 2. Conidiophores producing conidia in chains. 3. Ripe conidium at end of chain.

Braun (1982b).

Material examined: on *Salvia farinacea* Benth; various gardens, Pretoria, June 1982 and February 1983, PREM NO. 47222, on *Rosmarinus officinalis* L., glasshouse, Pretoria, August 1982, PREM NO. 47221.

Erysiphe cynoglossi (Wallr.) U. Braun (Syn. *E. asperifoliorum* Grev.)

On leaves and stalks. Mycelium moderately dense in spots. Hyphae slightly flexuous and branching at right angles. Appressoria nipple-shaped, often poorly developed (Figure 4). Conidiophores simple and straight (Figure 5), consisting of a long foot cell 50 – 100 × 11 – 12,5 µm and two shorter cells 12,5 – 20 × 12,5 – 14 µm. Conidia produced in chains without well developed fibrosin bodies, elliptic-ovoid to cylindric (Figure 6), (30 –) 35 (– 40) × (17,5 –) 18,7 – 20 (– 22,5) µm. Their quotient of relative length over relative width (L/W *ca* 1,85) is somewhat smaller than for *E. cichoracearum* DC (L/W *ca* 2,0). Germ tubes are shorter or as long as the conidia and originate from the end of a conidium, apical or subapical, seldom from the middle, frequently slightly twisted or broadened, seldom straight or forked, occasionally bent or helicoid, 20 – 30 × 5 – 10 µm.

This description of the anamorph agrees entirely with that by Braun (1980, 1982a) and is close to that of Boesewinkel (1979).

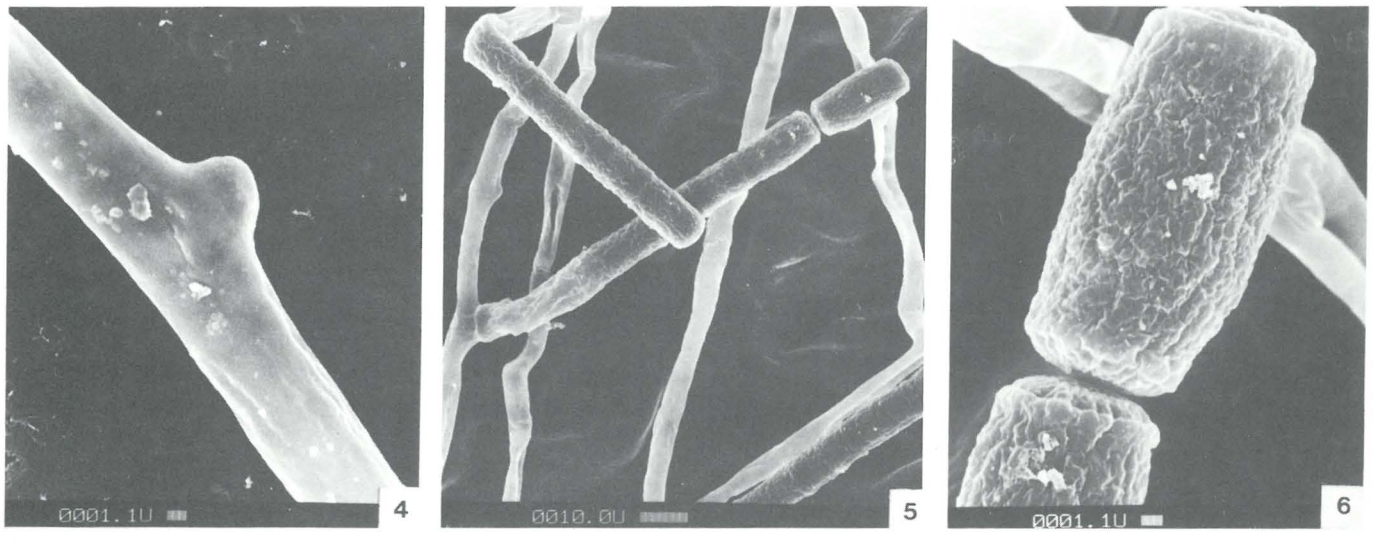
The isolated strain was found transmissable to tobacco, cucumber and *Viola tricolor* L. and is therefore a polyphagous race ('*E. polyphaga* Hamm'.).

Material examined: on *Papaver rhoeas* L. Roodeplaat, Pretoria, July 1982, PREM NO. 47177.

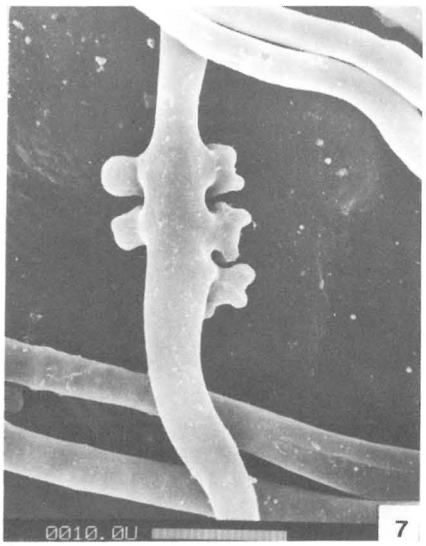
Erysiphe galeopsidis DC.

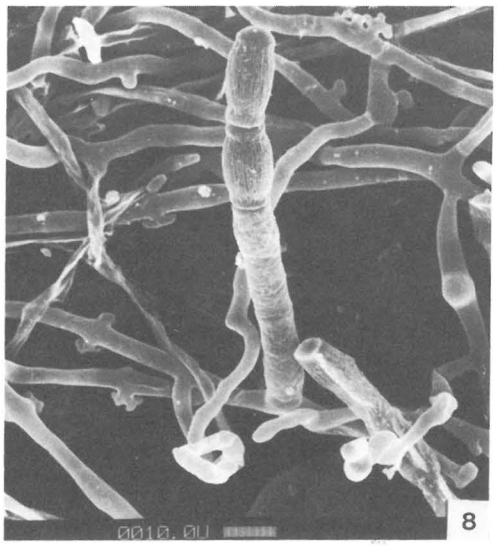
On leaves. Mycelium white. Hyphae varying in thickness, moderately flexuous but often geniculate, branching at right angles. Hyphal cells 42 – 53 × 7,5 – 10 µm. Appressoria moderately lobed or multilobed, abundant, often grouped together on opposite sides (Figure 7). Conidiophores straight 80 – 95,5 × 10 – 12 µm (Figure 8), 3 celled and producing conidia in chains.

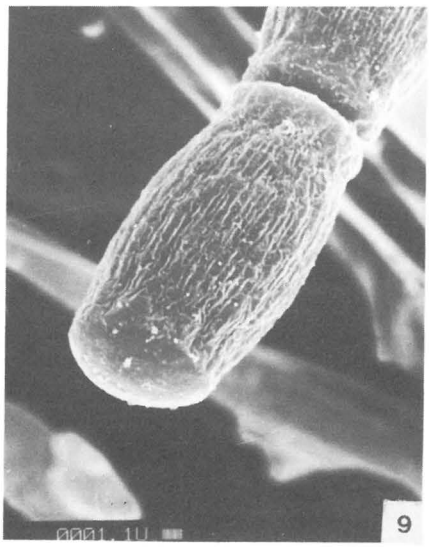
Foot cells are longer than the following cells *viz.* 35 – 50 µm compared with 17,5 – 27,5 µm. Conidia ovoid to barrel shaped with fine lengthwise ridges (Figure 9), (31,2 –) 35 – 40 (– 45) × (13,7 –) 17,5 – 20 (– 21,2) µm. No well developed fibrosin



Figures 4 – 6 *Erysiphe cynoglossi*. 4. Nipple-shaped appressorium. 5. Straight conidiophore and poorly developed appressorium. 6. Ripe conidium at end of conidial chain.







Figures 7 – 9 *Erysiphe galeopsidis*. 7. Lobed appressoria opposite and grouped. 8. Straight conidiophore producing conidia in chains. 9. Ripe conidium with lengthwise surface ridges.

bodies are produced. Conidia germinate sub-apically or from the side, either with a single forked or moderately lobed appressorium up to 15 μm long and 4 – 7,5 μm wide or with a straight tube up to 65 μm long.

Except for more squat mycelium cells this fungus agrees closely with the description by Boesewinkel (1979) of the anamorph of *E. galeopsidis* from *Geranium* leaves. The lengthwise ridges on the conidia are, however, a feature which has not been described before.

An interesting fact about *E. galeopsidis* is that, whereas we found the fungus occurring only epiphyllously on *Leonotus leonurus* R.Br., we found it only hypophyllously on *L. leonitis* R.Br. On *Ajuga reptans* L. its occurrence is amphigenous.

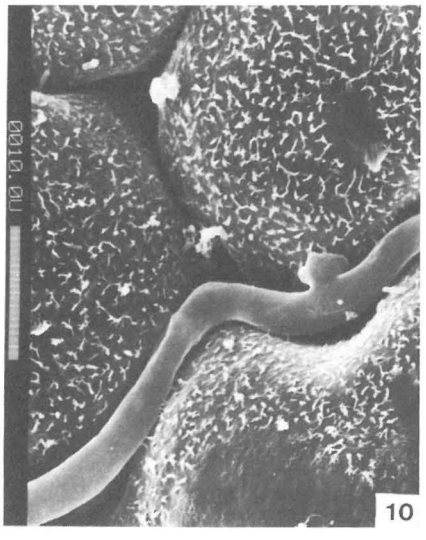
Material examined: on *Ajuga reptans*, Pretoria, May 1982, PREM NO. 47194, on *Leonotus leonurus*, Pretoria, March 1982 and Kirstenbosch November 1982, PREM NO. 47195, on *L. leonitis*, Stellenbosch, October 1982, PREM NO. 47196.

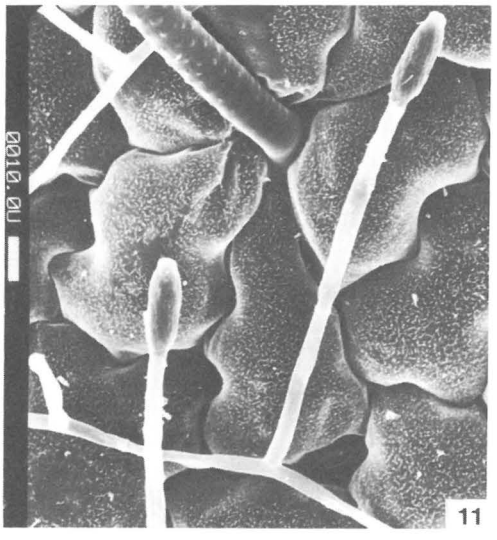
Microsphaera russellii Clint.

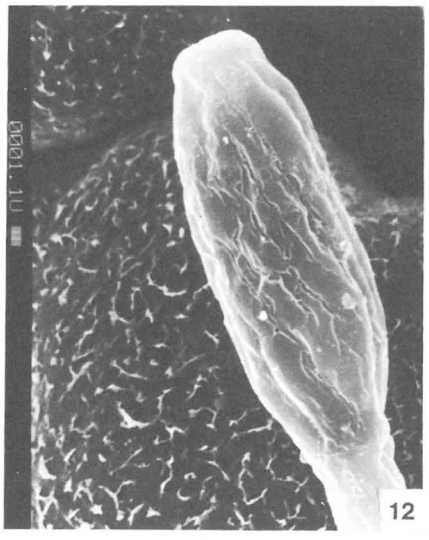
On leaves, amphigenous. Mycelium effuse, thin and white. Hyphae mostly straight and geniculate but bend to follow the outline of wax scales (Figure 10), sparingly branched at right angles, often near a septum. Hyphal cells (45 –) 70 – 75 (– 85) × 3,7 – 6,2 μm. Appressoria multilobed, usualy single (Figure 10). Conidiophores abundant, straight, consisting of 3 or occasionally 4 cells (Figure 11) of markedly varying length, 45 – 160 × 5(– 7,5) μm. In the shorter conidiophores (< 100 μm) the foot cell is the longest (22,5 –) 35 (– 55) × 5 – 6,2 μm. Conidiophores longer than 100 μm have a longer second cell as illustrated by Boesewinkel (1977), varying from 45 – 95 μm. A conidiophore has even been noticed where the third cell was the longest *viz.* two very short basal cells (12,5 μm) followed by a cell 40 μm longer.

Conidia produced singly but successive conidia can stick together in short chains which often break up on contact with water. They are ellipsoid (Figure 12), (25 –) 27,5 – 32,5 (– 40) × (11,2 –) 12,5 – 13,7 (– 15) μm and lack well developed fibrosin bodies. Germ tubes apical or sometimes sub-apical, straight, simple or occasionally branched, 17,5 – 70 × 3,7 μm, sometimes broadening towards the end (5 μm) suggesting the formation of an unlobed appressorium.

The conidial measurements reported above agree with those described for *M. russellii* by Parmelee (1977) and Braun (1982a)







Figures 10 – 12 *Microsphaera russellii*. 10. Moderately lobed appressorium on hypha following outline of wax scales. 11. Straight conidiophores with singly produced conidia. 12. Detail of conidium.

and for *Oidium oxalidis* McAlpine by Boesewinkel (1979). However, our description of the *Oidium* stage differs somewhat from that of Boesewinkel (1979) in that we found the foot cell in comparatively short conidiophores to be longer instead of shorter than the following cell and that conidia can remain joined together in short chains. Both these characteristics are known to occur in the genus *Microsphaera* Léveillé (Blumer 1967; Boesewinkel 1979). We are, therefore, convinced that the conidial stage of the powdery mildew on *Oxalis corniculata* L. in South Africa belongs to *Microsphaera russellii*, so far the only cleistothecial stage of an *Oidium* found on *Oxalis* spp. This agrees also with the opinion of Homma (1937) who considered *Oidium oxalidis* a synonym of *Microsphaera russellii*.

Material examined: on *Oxalis corniculata* L. glasshouse, Pretoria, October 1982, PREM NO. 47201.

Sphaerotheca verbenae Savulescu & Negru.

On leaves, amphigenous. Mycelium moderately dense, white to gray. Hyphae very flexuous, sometimes geniculate, branching at right angles often near a septum. Hyphal cells 35 – 90 µm long and (5 –) 7,5 (– 10) µm wide. Appressoria inconspicuous (Figure 13).

Conidiophores, 2 – 3 celled, seldom 4 celled, numerous, straight, with moderately long chains of ellipsoid to ovoid conidia (Figure 14). Well developed fibrosin bodies are present, 5 – 10 per conidium.

Conidiophores 75 – 135 × 10 – 12,5 µm, foot cells 45 – 90 × (10 –) 11,2 (– 12,5) µm often slightly constricted at their base and followed by straight-walled cells measuring 20 – 32,5 × 11,2 µm. Conidia (32,5 –) 35 (– 50) × (16,2 –) 17,5 (– 20) µm with a length width ratio (L/W) of *ca* 1,85 (Figure 15).

Germ tubes originate from the sides or sometimes subapically, comparatively short, 12,5 – 30 × 10 – 5 µm, simple, straight or geniculate, sometimes thicker near the base or forked with broad lobes approximately parallel to the surface of the conidium as in *S. xanthii* (Gorter & Eicker 1983).

The above description agrees very well with that of the anamorph of *Sphaerotheca verbenae* by Boesewinkel (1979) except that in South Africa the mildew is more epiphyllous than hypophyllous. The presence of well developed fibrosin bodies clearly distinguishes this species from *Oidium verbenae* Thuem. & Bolle which, according to Hammarlund (1945), is a synonym for *Erysiphe 'polyphaga'*.

Material examined: on *Verbena hybrida* Voss, Pretoria, August 1982, April 1983, PREM NO. 47181.

Uncinula australiana McAlpine.

On leaves, stalks and inflorescences. Mycelium dense, white, initially in spots, later confluent. Hyphae flexuous, 3 – 5 µm thick and cells 40 – 65 µm long. Appressoria multilobed, single or in pairs, often grouped together (Figure 16). Conidiophores straight, cylindrical, 3 celled, 65 – 75 × 7,5 µm producing conidia singly (Figure 17). Foot cell sometimes narrower at insertion point or in upper half of cell, 25 – 32,5 µm long and usually followed by two slightly shorter cells although three cells of equal length have been observed. Conidia ovoid to cylindric-ellipsoid, (25 –) 30 – 32,5 (– 38,7) × (12,5 –) 13,7 – 16,2 (– 18,7) µm, without any well developed fibrosin bodies (Figure 18). Although produced singly, successively formed conidia can stick together in short chains.

Germ tubes at end of conidium, up to 25 µm long, sometimes ending in one or two multilobed appressoria. These appressoria are often also produced on a very short tube.

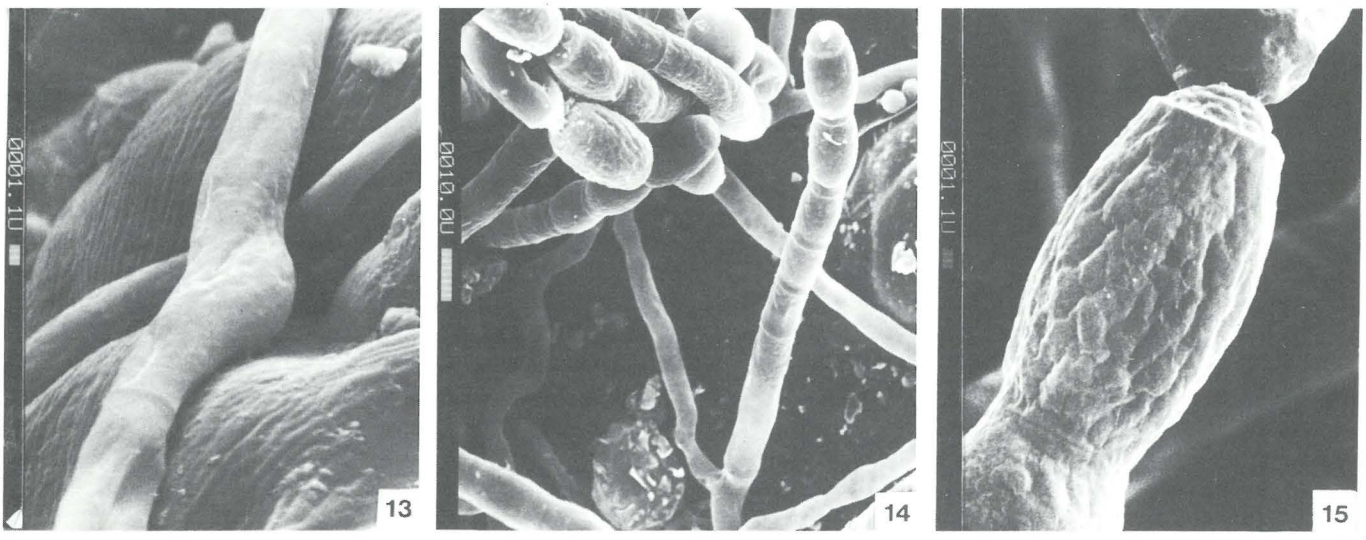
The above description of the anamorph agrees with those of Clare (1964), Viennot-Bourgin (1971), Hammett (1977) and Boesewinkel (1979).

Material examined: on *Lagerstoemia indica* L. Arcadia Park, Pretoria, October 1982, PREM NO. 47198.

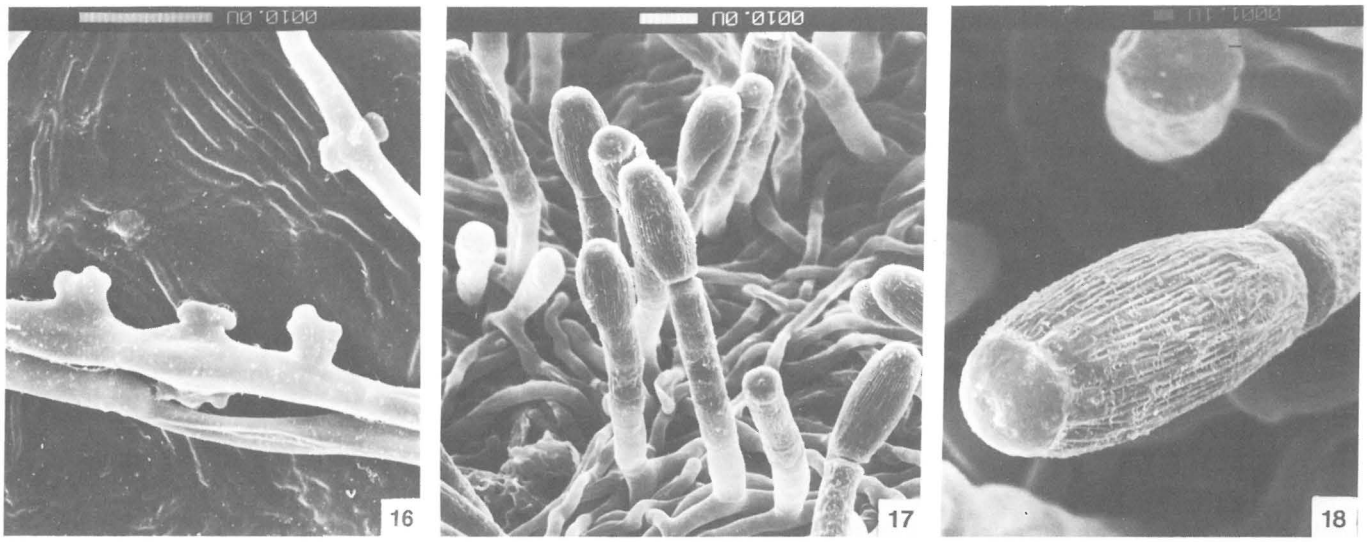
Discussion

A thorough study of anamorphs of powdery mildews in South Africa has uncovered the presence of a number of hitherto unreported Erysiphaceae. The occurrence of these fungi on *Ajuga reptans, Leonotus* spp., *Oxalis corniculata, Papaver rhoeas, Rosmarinus officinalis* and *Salvia farinacea* also denotes new host records for the country.

This study has also shown that the surface structure of conidia may be of importance in the taxonomy of powdery mildews. Hammett (1977) was the first to point out that distinct types of conidial surface structure could be observed in the Erysiphaceae and distinguished between smooth, spiny and hairy conidia. From the scanning electron micrographs



Figures 13 – 15 *Sphaerotheca verbenae*. 13. Inconspicuous appressorium. 14. Straight conidiophore with fairly long chain of conidia. 15. Detail of a chain conidium.



Figures 16 – 18 *Uncinula australiana*. 16. Multilobed and paired appressoria. 17. Numerous short straight conidiophores. 18. Secondary simply produced conidium with lengthwise surface ridges.

presented here it is clear that other surface structures exist, such as linear and net-like ridges. This indicates that a detailed study of conidial surface structure in the Erysiphaceae is required to determine the importance of this character in the taxonomy of this family.

In contrast with what has been found in the Uredinales (Sato & Sato 1982), it appears from a comparison of Figure 3, 6 and 9 that in the Erysiphaceae the conidia do not always have the same type of surface structure in the same genus and that similiar structures can occur in different genera (compare Figures 9 & 18).

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